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METHOD FOR DRIVING AN INK JET RECORDING DEVICE

[Inku Jetto Kiroku Sochi no Kudo Hoho]

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1. Title of the invention

Method for driving an ink jet recording device

2. Patent Claim

A method for driving an ink jet recording device characterized, with regard to an ink jet recording device wherein flow paths of a substrate on which closed channels scheduled to become ink flow paths have been formed are constituted by multiple pressure chambers and a group of nozzles corresponding to said pressure chambers and wherein drive sources are configured at positions corresponding to said pressure chambers, by the fact that all the nozzles used for printing impress, onto energy generation elements within a non-printing region, electric signals the levels of which are not high enough to induce ink flights at an identical timing.

3. Detailed explanation of the invention

(Industrial application fields)

The present invention concerns a method for driving an ink jet recording device designed to jet & record an ink used for a printer, etc. in accordance with an input signal.

[1] Numbers in the margin indicate pagination in the foreign text.

(Prior art)

Figure 1 shows an ink jet head used for an ink jet recording device known in the prior art. The substrate (1), on which channels corresponding to flow paths have been formed, is welded to the substrate (2), which is made of a material identical to that constituting the former, as a result of which ink flow paths & nozzles (5) become formed. An ink derived from an ink tank not shown in the figure is fed via the ink feeding gate (3) and then filled into the ink feed preparation chamber (4). Feeding gates leading to the respective nozzles are linked to said ink feed preparation chamber (4), based on which branched flow paths become formed. The pressure chamber (6) is configured midway along the flow path of each printing nozzle (5), whereas the piezoelectric element (7) is adhered to a site opposing the former, and in a case where an electric signal becomes fed into the latter, a pressure becomes impressed, via the substrate (2), onto the pressure chamber (6), as a result of which an ink droplet becomes jetted from the nozzle distal end (51).

In a case where an ink droplet thus becomes jetted from the nozzle distal end (51) in response to the impression of a signal onto the piezoelectric element (7), the ink becomes expanded around the nozzle hole on the nozzle plane, as a result of which an ink wall becomes formed. The ink wall thus generated during an ink jetting operation exerts an immense effect on the jetting angle of the jetted ink droplet. More specifically, as the frontal view diagram of Figure 2 (a) and profile view diagram of

(b) indicate, in a case where heterogeneous ink reserves become formed around /2

a nozzle hole, the flights of jetted ink particles become biased toward the small ink reserve side, for said ink reserves serve as a jetting wall. This phenomenon is especially noticeable immediately after a line change, etc. In a case where at least two consecutive inactive nozzles exist on the singular nozzle plane shown in Figure 4 (a) within the printing region of Figure 3, a homogeneously wetted pattern {ink reserve (10)} becomes formed, as Figure 4 (b) indicates. This wetting factor becomes temporarily drawn into the nozzle within the non-printing region but does not disappear completely, and the thin ink layer (101) becomes formed, as Figure 4 (C) indicates. For this reason, in a case where the ink becomes jetted, once again, from the previously inactive nozzles within the printing region, the ink reserves around the nozzle holes of the previously inactive nozzles become attracted toward the small ink reserve side in the initial printing phase, as Figure 4 (d) indicates, due to which ink droplet flight paths become curled, and, as Figure 4 (e) indicates, their flights become stabilized only after the sizes of the respective ink reserves have become virtually identical following the continuation of the printing operation to a certain stage. A method wherein ink droplets are periodically jetted within the non-printing region for forming a stable wetted state has been known as a countermeasure in the prior art.

(Problems to be solved by the invention)

Since unnecessary ink droplets are consumed within the non-printing region according to this method of the prior art, however, the ink running cost appreciates, and a component or waste ink receptacle for receiving the jetted ink droplet becomes necessary within this non-printing region, which is problematic from the standpoint of reducing the printer size.

(Mechanism for solving the problems)

The ink jet head of the present invention is characterized, in order to solve these problems, by the fact that the ink particle jetting angles of a group of printing nozzles are controlled while printing is in progress by driving all nozzles within the non-printing region by impressing, onto the piezoelectric elements thereof, electric signals the levels of which are not high enough to induce ink flights at an identical timing and by thus homogenizing the ink wetness of the nozzle hole peripherals of the printing nozzle group prior to the printing timing.

(Functions)

In a case where nozzles are configured according to the aforementioned description and where non-printing nozzles are driven, in the course of the uses of multiple printing nozzles for printing within the printing region, by impressing electric signals the levels of which are not high enough to induce ink

flights at a timing synchronized with the piezoelectric elements of printing nozzles being used for printing, the ink reserves seeping from non-printing nozzle holes become linked to the ink reserves around the nozzle holes of the printing nozzle group, and since the ink wetness of the nozzle hole peripherals of the printing nozzle group becomes homogenized, it becomes possible to control the ink jetting angle and to jet the ink along a direction perpendicular to the nozzle plane.

(Application example)

As Figure 5 indicates, as far as the present application example is concerned, even if nozzles from which no inks are being jetted exist within the printing region {Figure 5 (a)}, electric signals the levels of which are not high enough to induce ink flights are impressed onto the piezoelectric elements of the entire printing nozzle group within the non-printing region at an identical timing, as a result of which subtle vibrations become impressed onto the piezoelectric elements of the entire printing nozzle group, and the ink becomes spread around said nozzle holes {Figure 5 (b)}. It thus becomes possible, by homogenizing, before printing, the ink reserves around the nozzle holes of the entire printing nozzle group, to stabilize the flight angles of the ink droplets jetted from said printing nozzles within the printing region even during the initial printing phase {Figure 5 (c)}. The respective states of Figures 5 (d) & (e) represent repetitions of routines similar to the aforementioned ones of (a) & (b).

Figures 6 pertain to another application example, according to which the drive conditions for the piezoelectric elements of printing nozzles are differently designated between the printing region & non-printing region, and all printing nozzles are driven within the non-printing region to the extent that no ink droplet will become jetted. Figure 6 (a) shows the drive wave form the piezoelectric elements of the printing nozzle group. VH signifies the drive voltage impressed onto the piezoelectric element, whereas Pwd signifies the duration of the discharge of charges from the piezoelectric element, whereas Pwc signifies the time required for the recharging of said piezoelectric element with charges, whereas the discharge curve A & discharge curve B are each curves arising depending on the capacitance and discharge & recharge resistances of the piezoelectric element as well as on the drive voltage impressed onto the piezoelectric element. The piezoelectric element is curled in a standby state by impressing the voltage VH along the contracting direction of the piezoelectric element. In a case where the voltage being impressed onto the piezoelectric element becomes cancelled, the curl of the piezoelectric element becomes eliminated, as a result of a depressed state becomes achieved within the pressure chamber, and the ink in the vicinity of the nozzle and ink derived from the ink feeding path become fed.

Next, in a case where a voltage becomes impressed, once again, onto the piezoelectric element, the piezoelectric element becomes contracted, and the ink becomes pressurized, as a result

of which the ink becomes jetted from the nozzle. The ink subsequently becomes fed based on the /3 surface tension of the nozzle, and the meniscus becomes stabilized in the nozzle orifice portion, as a result of which a standby state becomes achieved. As far as the present application example is concerned, the printing energy impressed onto the piezoelectric elements within the non-printing region is designated at a level lower than that of the printing energy impressed within the printing region by changing piezoelectric element drive conditions, based on which subtle vibrations become impressed onto the piezoelectric elements to the extent that no ink droplets become jetted. More specifically, it is conceivable to change the electric signals impressed onto the printing nozzles within the non-printing region according to the following schedule:

(1): The discharge time Pwd is abbreviated {Figure 6 (b)};

(2): The drive voltage VH impressed onto the piezoelectric element is attenuated {Figure 6 (c)};

(3): The discharge resistance is elevated {Figure 6 (d)};

(4): The recharge resistance is elevated {Figure 6 (e)}.

All the nozzles within the non-printing region become, according to the foregoing schedule, driven under the aforementioned conditions in a case where multiple nozzles simultaneously engage in printing on a singular substrate, and since the ink cannot be jetted from the nozzle hole, the ink becomes spread around the nozzle hole, as a result of which the ink reserves around the

nozzle holes of the printing nozzle group become homogenized prior to the printing timing.

Incidentally, even in the case of a recording medium liquid extrusion recording method wherein electrothermal converters are configured within flow paths in place of piezoelectric elements and wherein an ink within a nozzle is jetted by using a thermal energy, too, effects similar to those of the aforementioned application examples can be achieved by varying the drive current and voltage impression time in such a way that an energy the magnitude of which does not induce an ink flight will become exerted onto the heat generation unit within the printing nozzle flow path within the non-printing region. The types of drive sources are not limited in the present invention.

(Effects of the invention)

As the foregoing explanations have demonstrated, the ink jet recording device of the present invention promises, by homogenizing ink reserves around all printing nozzle holes within the non-printing region prior to the printing timing, an effect of inhibiting the irregularities of ink jetting directions. Since there is no need to jet unnecessary ink droplets, furthermore, the ink can be effectively used for printing purposes alone. Since no component for receiving an ink is required within the non-printing region, furthermore, a compact printer can be realized.

4. Brief explanation of the figures

Figure 1 is a demonstrational diagram pertaining to a device known in the prior art.

Figures 2 and 4 are each diagrams which show the ink reserve states around the nozzle holes of the device of the prior art.

Figure 3 is a diagram which shows the printing region and non-printing region for the device of the prior art.

Figures 5 are profile view diagrams of nozzle holes, where ink reserve states around the nozzle holes of an application example of the present invention are shown.

Figure 6 is a demonstrational diagram pertaining to another application example of the present invention.

(1): First substrate;

(2): Second substrate;

(3): Ink feeding gate;

(4): Ink feed preparation chamber;

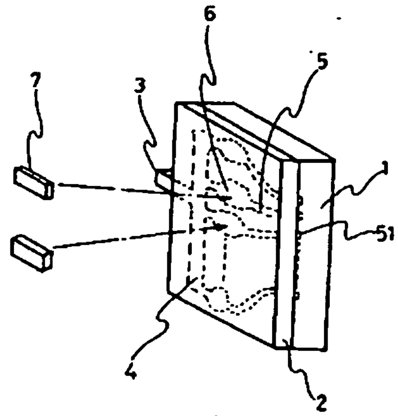
(5): Printing nozzle;

(6): Pressure chamber;

(7): Piezoelectric element.

[END]

Figure 1



Figures 2

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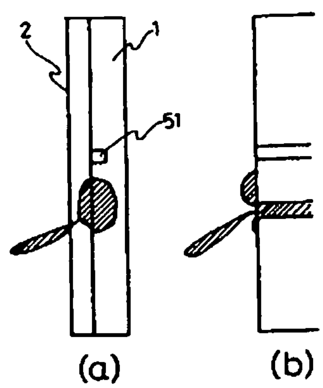
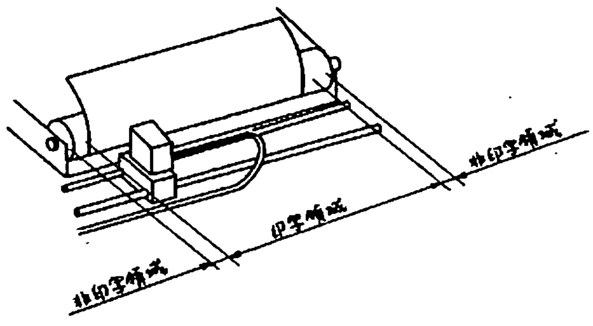
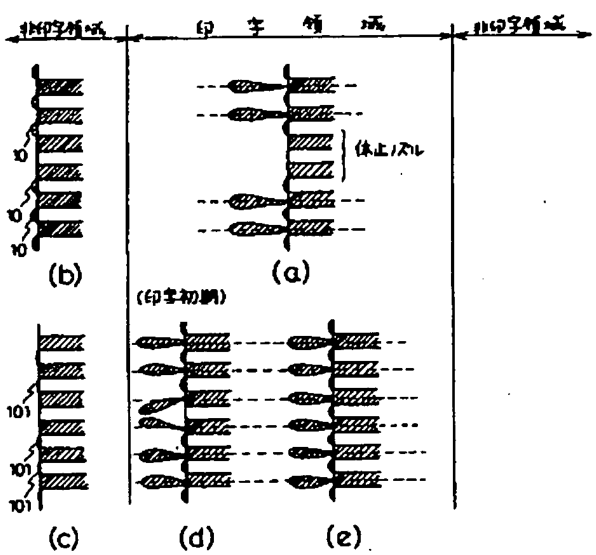


Figure 3



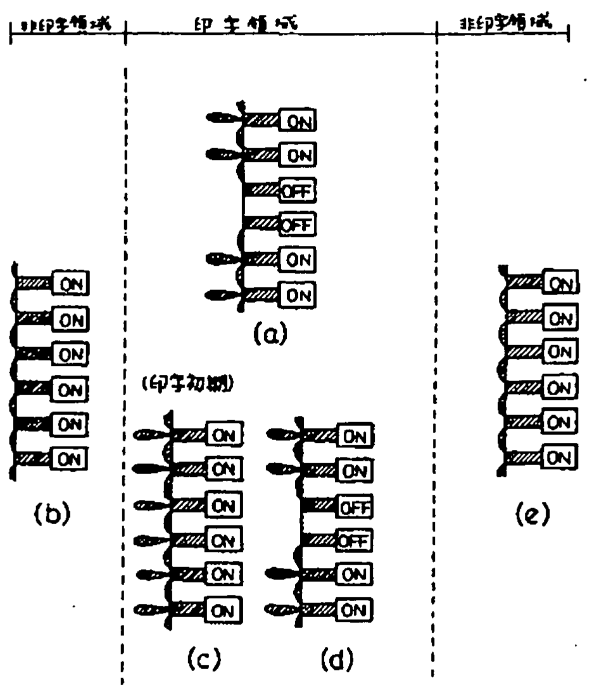
[(1): Non-printing region; (2): Printing region]

Figures 4



[(1): Non-printing region; (2): Printing region; (3): Inactive nozzles; (4): Initial printing phase]

Figures 5



[(1): Non-printing region; (2): Printing region; (3): Initial printing phase]

Figures 6

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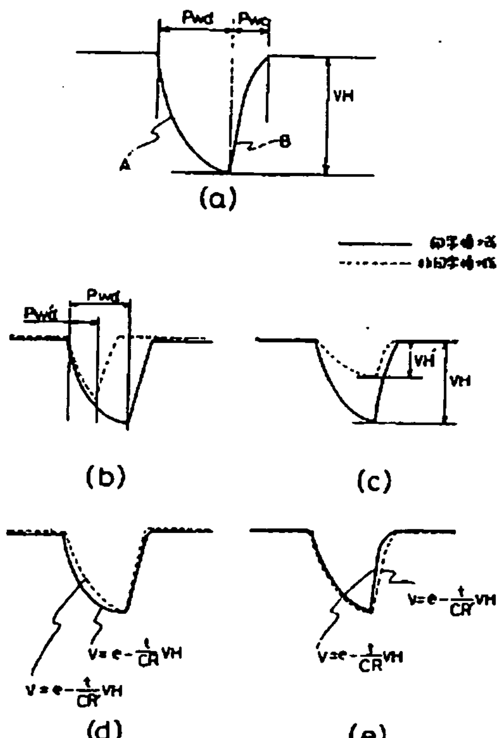

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[(1): Non-printing region; (2): Printing region]